Table 2. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Salt Creek (Cont'd)					
Just upstream of Deadman's Run confluence	469.4	18,500	24,000	30,100	43,500
Just downstream of Oak Creek confluence	465.8	18,300	29,000	36,000	44,000
Just upstream of Oak Creek confluence	296.8	12,300	29,000	36,000	44,000
Just downstream of Antelope Creek confluence	296.8	12,300	29,000	36,000	44,000
Just upstream of Antelope Creek confluence	289.4	12,200	28,900	35,900	44,000
Just downstream of 10th Street	289.4	12,200	29,200	36,200	44,800
Just upstream of 10th Street	289.4	12,200	29,100	36,100	44,800
Just downstream of Union Pacific Railroad	289.2	12,200	30,000[1]	37,500[1]	47,500[1]
Just upstream of Union Pacific Railroad	288.8	12,200[2]	22,200[2]	27,700[2]	36,100[2]
Just downstream of Middle Creek confluence	285.6	12,100[2]	21,300[2]	26,500[2]	35,800[2]
Just upstream of Middle Creek confluence	230.6	7,300[2]	13,600[2]	16,900[2]	22,200[2]
Just downstream of Haines Branch confluence	227.6	7,300[2]	13,300[2]	16,600[2]	22,900[2]
Just upstream of Haines Branch confluence	174.6	5,400	10,000	12,400	15,200
Just downstream of Beal Slough confluence	173.6	5,200	9,800	12,200	15,000

[1]Oak Creek and Salt Creek flood discharges were combined at this location in both the hydrologic and hydraulic models because of a combined floodplain.

[2]Discharges shown are not peak discharges; however, these discharges do produce the maximum water-surface elevation at these locations.

Table 2. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Salt Creek (Cont'd)					
Just upstream of Beal Slough confluence	160.7	3,800	7,100	8,800	14,000
At Old Cheney Road	157.0	4,100	7,600	9,500	14,800
Just downstream of Cardwell Branch confluence	155.7	4,300	8,000	10,000	15,200
Stevens Creek					
At mouth	55	6,600	7,700	8,100	10,500
Just upstream of U.S. Highway 6	--[1]	6,500	7,600	8,000	10,400
Just downstream of Stevens Creek Overflow	--[1]	8,500	11,300	13,100	16,700
Just downstream of Havelock Avenue	--[1]	9,400	14,600	17,400	22,800
Just upstream of Adams Street	--[1]	9,600	14,800	17,700	23,200
Just downstream of confluence with Stevens Creek Tributary	--[1]	10,800	16,700	19,800	25,700
Just upstream of A Street	--[1]	8,000	11,900	14,000	17,700
About 2,800 feet downstream of Van Dorn Street	22.0	8,170	12,200	14,150	19,300
At Van Dorn Street	21.1	8,400	12,800	14,920	20,000
At Pioneers Boulevard	11.1	4,390	6,600	7,660	10,500
At Old Cheney Road	8.4	3,480	5,300	6,050	8,400
At Pine Lake Road	7.1	3,320	4,900	5,790	7,800
At Yankee Hill Road	2.0	1,220	1,800	2,090	2,800
Stevens Creek Overflow					
At mouth	--[1]	2,200	6,100	8,300	12,000
Just upstream of U.S. Highway 6	--[1]	2,200	6,100	8,300	12,000
Downstream of divergence from Stevens Creek	--[1]	1,700	5,200	6,500	9,500

[1]Data not available

Table 2. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Stevens Creek Tributary					
At mouth	_[1]	2,100	3,300	3,900	5,100
Upstream of 120th Street	_[1]	2,200	3,400	4,000	5,300

[1]Data not available

Table 3. Manning's "n" Values

Flooding Source	Roughness Coefficients	
	Channel	Overbanks
Antelope Creek	0.015 – 0.045	0.050 – 0.100
Ash Hollow Ditch	0.060	0.100
Beal Slough	0.040 – 0.045	0.060 – 0.080
Cardwell Branch	0.045	0.070 – 0.090
Elk Creek	0.045	0.070
Haines Branch	0.040	0.065 – 0.090
Hickman Branch	0.050	0.100
Hickman Branch Tributary	0.050	0.140
Little Nemaha River	0.050	0.056
Lynn Creek	0.040 – 0.045	0.070 – 0.100
Middle Branch Big Nemaha River	0.065	0.110
Middle Creek	0.030 – 0.045	0.060 – 0.080
North Oak Creek	0.040	0.065
Oak Creek	0.030 – 0.040	0.060 – 0.090
Salt Creek	0.028 – 0.040	0.060 – 0.100
South Branch Middle Creek	0.040	0.065
Stevens Creek	0.045 – 0.070	0.060 – 0.120
Stevens Creek Overflow	0.055 – 0.060	0.080 – 0.100
Stevens Creek Tributary	0.035 – 0.085	0.070
Unnamed Tributary to Little Nemaha River	0.050	0.056

based on stage-discharge relationships along coincident streams. Starting water-surface elevations for the remainder of the streams in Lancaster County and all other communities were established by the slope-area method contained in the HEC-2 computer program.

Profiles were determined for the 10-, 50-, 100-, and 500-year floods. Head losses at bridges were computed using the methodology outlined in "Hydraulics of Bridge Waterways" (Reference 37) and the Special Bridge Routine contained in HEC-2 (Reference 36). Flood profiles for streams studied in detail were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

The water-surface profiles for Stevens Creek, Stevens Creek Overflow, and Stevens Creek Tributary were developed using the NRCS WSP-2 computer program (Reference 38).

Levees are located along both banks of Salt Creek from the downstream end of the Federal levee system (Superior Street) to the downstream study limit. These levees are variable in height and have unknown structural integrity. These levees were not considered as barriers to floodflows for the purposes of this study.

Areas of the community protected by a levee along the eastern bank of Oak Creek southwest of Lincoln Municipal Airport are subject to potential risk due to possible failure or overtopping of the levee along Oak Creek. This area was delineated by applying the 500-year elevation determined from the without-levee analysis.

In some areas along Salt Creek, the computed water-surface elevations are lower in the channel between the levees than in the overbank areas landward of the levees. This is due to the fact that floodwaters in Salt Creek overtop the channel banks and combine with the Oak Creek overflow in the area upstream of the confluence of Oak Creek with Salt Creek. As a result, the combined overflow from Salt Creek and Oak Creek is not confined within the levee system extending from upstream of the confluence of Oak Creek with Salt Creek to downstream of Superior Street. The computed overbank flood elevations for the areas landward of the Salt Creek levee system were determined by an independent hydraulic analysis originally prepared by the USACE, Omaha District. These overbank elevations were determined to be higher than the computed 100-year water-surface elevations for the Salt Creek channel and are presented that way in this Flood Insurance Study.

Hickman Branch was analyzed as one reach. Significant factors in the hydraulic analysis of Hickman Branch included the bridge at State Highway 477, the BNRR bridge, and the bridge at Chestnut Street. Hickman Branch Tributary was analyzed as one reach. Significant factors in the analysis included bridges at Seventh Street and Main Street and the Missouri Pacific Railroad Bridge.

The Little Nemaha River was analyzed in two reaches. The first reach is from the downstream limit of detailed study upstream to the State Highway 43 bridge. The second reach continued upstream to the limit of detailed study. The Unnamed Tributary was analyzed in one reach. Significant factors in the analyses were to determine the line of interflow between the two streams. This line was determined to be below the State Highway 43 bridge between Cross Sections B and C. There are three bridges in the study reach that were carefully analyzed to determine the backwater produced and to determine whether road overflow would occur.

The streams studied were analyzed in reaches as described in Section 2.1. Significant factors in the hydraulic analyses were the computation of backwater from bridges, the general meander of the streams, and the evaluation of overflow and effective flow areas beyond adjacent railroad tracks.

Flood elevations for stream segments studied by approximate methods in the Village of Bennet were determined by normal depth analysis, Flood Prone Area Maps (Reference 39), and the Flood Hazard Boundary Map (Reference 40).

The elevations for approximate study areas in the Village of Firth were determined by extending energy grade lines from the detailed study areas and by normal depth calculations.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the [National Geodetic Vertical Datum of 1929 (NGVD). Elevation Reference Marks (ERMs) and their descriptions are shown on the maps. ERMs shown on the FIRM represent those used during the preparation of this and previous Flood Insurance Studies. The elevations associated with each ERM were obtained and/or developed during FIS production to establish vertical control for determination of flood elevations and floodplain boundaries shown on the FIRM. Users should be aware that these ERM elevations may have changed since the publication of this FIS. To obtain up-to-date elevation information on National Geodetic Survey (NGS) ERMs shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov. Map users should seek verification of non-NGS ERM monument elevations when using these elevations for construction or floodplain management purposes.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 100-year floodplain data, which may include a combination of the following: 10-, 50-,100-, and 500-year flood elevations; delineations of the 100-year and 500-year floodplains; and 100-year floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet (Reference 28), and at a scale of 1:4,800, with a contour interval of 4 feet (Reference 31).

Some areas in the City of Lincoln that are protected from the 100-year flood by a levee along Oak Creek have been delineated as having potential risk due to possible failure or overtopping of the levee during larger floods.

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, and AO), and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Insurance Rate Map (Exhibit 2).

Approximate flooding in the Village of Bennet was delineated from the Flood Prone Area Maps (Reference 39) and the Flood Hazard Boundary Map (Reference 40). For the approximate study area in the Village of Firth, the flood boundaries were delineated on topographic maps (Reference 28) and on the basis of field reconnaissance or extending energy grade lines if the area adjoined a detailed study area.

For the streams studied by approximate methods in the City of Lincoln, the boundaries of the 100-year flood were developed from normal depth calculations and USGS 7.5-minute series topographic maps (Reference 28). Flood boundaries on Deadman's Run were taken from a previous Flood Insurance Rate Map for the City of Lincoln (Reference 41).

The boundaries of the approximate areas in the Village of Raymond were delineated on the same maps as those used for the detailed study areas (Reference 28).

For the City of Waverly, the approximate flooding boundaries for the portion of Ash Hollow Ditch and Unnamed Tributary Nos. 1 and 2 were obtained from the Lancaster County Flood Hazard Boundary Map (Reference 42). The approximate 100-year flood boundaries were then delineated using topographic maps (Reference 28).

Approximate 100-year floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map for Lancaster County (Reference 42).

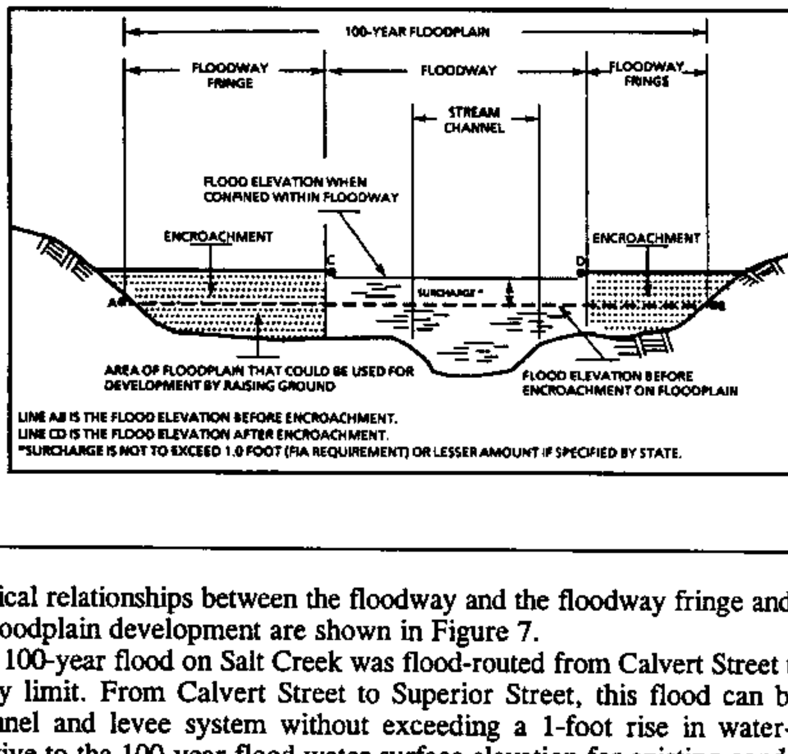
4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies. The concept of the floodway and the 1-foot-rise criteria are also contained in Nebraska State Law, as enforced by the NNRC.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain (HEC-2, Method 4) and by specifying left- and right-bank encroachment stations (HEC-2, Method 1) (Reference 36). The floodways on Stevens Creek, Stevens Creek Overflow, and Stevens Creek Tributary were computed using the NRCS WSP-2 floodway run (Reference 38). The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (see Table 4, "Floodway Data"). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1 foot at any point. However, because of the characteristics of Salt Creek and its floodplain, the traditional uses of the floodway fringe are not entirely applicable.

Figure 7. Floodway Schematic



Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 7.

The 100-year flood on Salt Creek was flood-routed from Calvert Street to the downstream study limit. From Calvert Street to Superior Street, this flood can be confined to the channel and levee system without exceeding a 1-foot rise in water-surface elevation relative to the 100-year flood water-surface elevation for existing conditions. This is the floodway boundary shown in this study. The area landward of this boundary, the floodway fringe, is traditionally an area in which complete fill of the floodplain is permissible. However, as described in Section 3.1, the area landward of this floodway boundary is used by Salt Creek for the storage of floodwater, thus reducing the peak discharge to the values shown in Table 2, Summary of Discharges." If complete fill of the storage areas occurs, the Salt Creek flood peak discharges shown in Table 2 would increase. These peak discharges would result in water-surface elevations in the floodway that exceed the 1-foot-rise criteria. To ensure that Salt Creek peak discharges do not increase from those values in Table 2 because of loss of floodplain storage, the storage volume in the floodway fringe should be preserved. Table 5, "Percentage by Volume of Allowable Fill in the Salt Creek Floodway Fringe," provides percentages of the total volume in the floodway fringe beneath the floodway elevations from Calvert Street to Superior Street that can be filled without reducing the amount of storage in the floodway fringe necessary to preserve the Salt Creek peak discharges listed in Table 2.

Due to the nonconveyance characteristics of Holmes Lake, no floodway is shown in this area.

The Salt Creek profile was extrapolated upstream of Cross Section BR; therefore, there is no floodway upstream of this cross section.

Due to the insufficient capacity of the culvert and no distinct channel for Antelope Creek between M Street and Vine Street, no floodway is delineated in this area.

For the portion of Ash Hollow Ditch from just downstream of Farm Road to 200 feet downstream of the BNRR, the floodway is coincident with the banks of the channel. Consequently, no formal floodway is proposed and the 100- and 500-year floods are shown to be contained within the channel downstream of Cross Section H.

No floodway was determined for Oak Creek from approximately 900 feet upstream of the confluence of North Oak Creek to the upstream limit of detailed study at State Highway 79 because of the low potential for development in this area.

The floodway for North Oak Creek in the area of West Raymond Road was determined to be split flow. The floodway width at this area is given as the sum of the two flows.

No floodways were computed for some of the detailed studied streams because it was not in the scope of the study.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base (100-year) flood elevations (BFEs) or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Table 5. Percentage by Volume of Allowable Fill in the Salt Creek Floodway Fringe

Location	Left Overbank (percent)	Right Overbank (percent)
Van Dorn Street to South Street	100	25
South Street to A Street	100	35
Area west of BNRR tracks from A Street to South Street	100	--
A Street to BNRR yards	100	25
BNRR yards to O Street	10	100
O Street to Union Pacific Railroad		
Union Pacific Railroad to Interstate 180	15	15
Interstate 180 to 14th Street	100	35
14th Street to Chicago and North Western tracks	--	30
14th Street to 27th Street	35	--
27th Street to Chicago and North Western tracks	100	--
Chicago and North Western tracks to Superior Street	90	75